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Document Title **Calorimeter Front-End Electronics Board Specification**		

Gamma-ray Large Area Space Telescope (GLAST)

Large Area Telescope (LAT)

Calorimeter Analog Front End Electronics (AFEE) Board Requirements

DOCUMENT APPROVAL

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CHANGE HISTORY LOG

Revision	Effective Date	Description of Changes

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1 PURPOSE

This document describes the specifications of the GLAST Calorimeter Analog front end Electronics (AFEE) boards.

2 SCOPE

This document describes the specifications of the AFEE boards themselves. Separate documents specify the requirements of components on the boards. The GLAST Calorimeter Front-End Electronics (GCFE) ASIC and the GLAST Calorimeter Readout Controller (GCRC) digital ASIC in particular each have their own design and requirements documents. In addition to the specifications outlined in this document, the AFEE are also subject to the applicable EEE parts specifications, QA specifications and environmental specifications.

3 DEFINITIONS

3.1 Acronyms

CAL	LAT calorimeter subsystem
FWHM	Full Width Half Maximum
GLAST	Gamma-ray Large Area Space Telescope
IRD	Interface Requirements Document
LAT	Large Area Telescope
SI/SC IRD	Science Instrument – Spacecraft Interface Requirements Document
SRD	Science Requirements Document
TBR	To Be Resolved
TEM	Tower Electronics Module
TRG	L1 Trigger

3.2 Definitions

γ	Gamma Ray
μsec, μs	Microsecond, 10^{-6} second
A_{eff}	Effective Area
Analysis	A quantitative evaluation of a complete system and /or subsystems by review/analysis of collected data.
Arcmin	An arcmin is a measure of arc length. One arcmin is 1/60 degree.
Background Rejection	The ability of the instrument to distinguish gamma rays from charged particles.
Backsplash	Secondary particles and photons originating from very high-energy gamma-ray

	showers in the calorimeter giving unwanted ACD signals.
Beam Test	Test conducted with high energy particle beams
cm	centimeter
Cosmic Ray	Ionized atomic particles originating from space and ranging from a single proton up to an iron nucleus and beyond.
Dead Time	Time during which the instrument does not sense or record gamma ray events during normal operations.
Demonstration	To prove or show, usually without measurement of instrumentation, that the project/product complies with requirements by observation of results.
eV	Electron Volt
Field of View	Integral of effective area over solid angle divided by peak effective area.
GeV	Giga Electron Volts. 10^9 eV
Inspection	To examine visually or use simple physical measurement techniques to verify conformance to specified requirements.
MeV	Million Electron Volts, 10^6 eV
μsec, μs	Microsecond, 10^{-6} second
ph	photons
s, sec	seconds
Simulation	To examine through model analysis or modeling techniques to verify conformance to specified requirements
sr	steradian, A steradian is the solid (3D) angle formed when an area on the surface of a sphere is equal to the square of the radius of the sphere. There are 4 Pi steradians in a sphere.
Testing	A measurement to prove or show, usually with precision measurements or instrumentation, that the project/product complies with requirements.
Validation	Process used to assure the requirement set is complete and consistent, and that each requirement is achievable.
Verification	Process used to ensure that the selected solutions meet specified requirements and properly integrate with interfacing products.

4 APPLICABLE DOCUMENTS

Documents that are relevant to the development of the AFEE specifications include the following:

GLAST00010, “GLAST Science Requirements Document”, P.Michelson and N.Gehrels, eds., July 9, 1999.

LAT-SP-00010, “GLAST LAT Performance Specification”, August 2000

LAT-SS-00018, “LAT CAL Subsystem Specification”, January 2001

LAT-SS-00211, Specification for the Calorimeter Photodiode Flexible Cable

LAT-SS-00087, Calorimeter Electronics System – Conceptual Design

LAT-SS-00088, Calorimeter Front End Electronics ASIC – Conceptual Design

LAT-SS-00089, Calorimeter Front End Electronics ASIC Specification

LAT-SS-00208, Calorimeter Readout Control ASIC – Conceptual Design

5 REQUIREMENTS

5.1 Introduction

The *GLAST* Calorimeter consists of 16 identical calorimeter modules. To minimize gaps between calorimeter modules, the amount of space and materials used up by the electronics should be minimized. This has led to a compact calorimeter module design. An exploded view of a calorimeter module is shown in Figure 1. Each calorimer module is roughly a cube, with detectors signals on the four vertical module sides. The AFEE boards receive the signals of the PIN photodiodes that are connecetd to the CsI crystals as their inputs, and process the signals into digital signals that are transmitted to the TEM board as their outputs. The boards contain custom analog front end amplifier Application Specific Integrated Circuits (ASICS) [the GCFE (GLAST Calorimeter Front-End Electronics)], commercial Analog to Digital Converters (ADCs), custom ditigal ASICs [the GCRC (GLAST Calorimeter Readout Controler)], a commercial Digital to Analog Converter (DAC) and other ancilliary components. The four boards are not identical because the crystal stacking is intrinsically different between the X and Y coordinates (the top row is either in the X or Y direction, but not both). This document addresses the requirements of the component labeled as AFEE board in Figure 1.

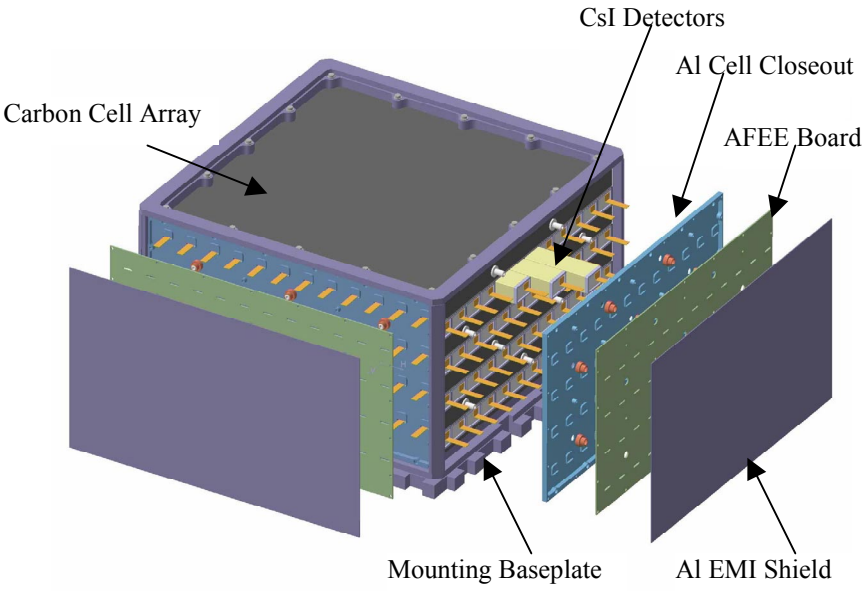

Figure 1. Exploded view of a single Calorimeter module. Eight layers of 12 CsI Crystals are readout by PIN photodiodes and electronics on the four module sides.

5.2 Detailed Requirements

5.2.1 Functionality

Each board shall hold the GCFEs, ADCs, GCRCs, a DAC (for calibrations), a temperature sensor and all these components' associated electronics. The AFEE boards shall also support whatever additional electronics or sensors are deemed necessary in the location of the AFEE boards.

5.2.2 Types of AFEE boards

There shall be two types of AFEE boards, named X-boards and Y boards, for the direction of the crystals they service. The two X (Y) boards are then separated in to a –X (-Y) and + X (+Y) board, depending on which side of the calorimeter they service. . The +X and –X boards shall be identical except for a hardwired control (jumper) that selects whether a board is a + or – board. The same rule applies for the Y boards.

5.2.3 Channel numbers and Layout

Each AFEE board shall service 48 crystal ends. These crystal ends are arranged in 4 layers of 12 crystals. The crystal pitch is ~ 28 mm, the layer pitch is ~ 42 mm. The AFEE layout shall minimize the connection distance between the PIN diode and the GCFE. The – X and -Y boards shall have the channel number within a row increasing from right to left, the +X and +Y boards shall have the channel number within a row increasing from left to right. Left and right a determined by looking from the outside of a board with the Z-axis pointed up.

5.2.4 PIN Diode Interface

Each crystal end shall connect to the GCFE with a polyimide cable fed through a hole in the AFEE board. The hole for the polyimide cable shall be at least 8 mm by 2mm. A bending radius of 1 mm is allowed in the corners of the holes. The polyimide cable shall be connected to the AFEE board using a space qualified connection method. The polyimide cable is defined in LAT-SS-00211, “Specification for the Calorimeter Photodiode Flexible Cable”.

5.2.5 Operating voltages

Each AFEE board is provided with two voltages: one 3.3V voltage to operate the AFEE board itself, and one high voltage in the negative 70-100 volt range to bias the PIN diodes. The regulations of these voltages shall not happen on these boards, but the boards shall filter these voltages appropriately.

5.2.6 TEM Electrical Interfaces

The AFEE board shall communicate to the Tower Electronics Module (TEM) through Low Voltage Differential Signaling (LVDS). No common ground shall span the connection.

5.2.7 Mechanical Dimensions

Each AFEE board shall have maximal dimensions of XXX mm by XXX mm. The maximal thickness of the board shall be 2 mm. The maximal thickness of the board and its components shall be 8 mm. No component shall be raised more than 3 mm from either surface of the board.

5.2.8 Mechanical Interfaces

Each AFEE board shall be supported around its perimeter and with posts traversing the board.

There shall be 10 posts passing through the board in layers of 2 or 3 posts. The layers of posts shall be located half way between layers of PIN diode interface holes. The diameter of the hole in the AFEE boards for the posts shall be XXX mm. No component shall be located within XXX mm of the hole. No trace on the board shall be within XXX mm of the hole.

No component shall be located within XXX mm of the outside perimeter of the AFEE board. No trace on the board shall be within XXX mm of the perimeter of the board.

5.2.9 Power

Each AFEE board shall not use more than 1.25 Watts from the 3.3V supply.

Each AFEE board shall not use more than 0.001 Watts of the 70-100 V voltage line.

5.2.10 Thermal Requirements

5.2.10.1 Operating Temperature Range

The performance specifications of the AFEE shall be achieved over the operational temperature range of –10 to 35 degrees C.

5.2.10.2 Storage Temperature Range

The AFEE shall be capable meeting its performance specifications after indefinite storage in the temperature range of -20 to 40 degrees C.

5.2.10.3 Qualification Temperature Range

The performance of the AFEE shall be tested over the qualification temperature range of –30 to 50 degrees C. It shall survive testing over this range and meet performance specifications when returned to the operational temperature range.

5.2.11 Grounding

The AFEE board shall be grounded to the calorimeter per LAT document LAT-SS-00272-D1, LAT Grounding and Shielding Plan.

5.2.12 AFEE Failure

Each AFEE board shall be constructed such that an electrical or electronic failure of one board does not affect any of the other three boards of the same calorimeter module, or the two provided voltages.

5.2.13 Coating

Each AFEE board shall be coated with conformal coating per specification XXX.